# EFFECT OF PEER TEACHING AMONG STUDENTS ON THEIR PERFORMANCE IN MATHEMATICS

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**ABSTRACT**

*Mathematics is a key subject in the school curriculum and is considered as critical filter for learners' career choices. However, over the years mathematics has been one of the poorly performed subjects in the Kenya Certificate of Secondary Education (KCSE). In an attempt to improve performance, great effort has been put into use of appropriate teaching and learning methods that stimulate learners' interest in the subject. This study was done in 12 randomly selected schools in Bungoma South Sub County. The objective of this study was to determine the effect of peer teaching among students on their performance in mathematics in the teaching and learning process. The study was guided by Vygotsky's social interaction theory of learning. This theory opines that social interaction plays a fundamental role in cognitive development and that all learning occurs in a cultural context and involves social interactions where peers assist learners in developing new ideas and skills. The target population was heads of departments, teachers of mathematics and form three students. Twelve heads of department, twenty four mathematics teachers and one hundred and seventy six form three students were drawn from the sampled schools to participate in the study. A descriptive survey design was adopted for the study. Data was collected using a teachers' questionnaire, students' questionnaire, interview schedule for heads of department and students' achievement test. Data was analyzed using Statistical Package for Social Sciences (SPSS) version 17.0 and Statistical t-test. The Students' Achievement test showed that peer teaching increases students' achievement in mathematics and 100% of the heads of department interviewed believe that peer teaching strategy improves performance. The conclusions made from the study were that peer teaching encourages students' motivation to learn mathematics, enhances understanding of mathematics concepts and builds confidence in the students. Students should be allowed to form discussion groups where peer teaching can be done especially at the end of every topic as it offers a great opportunity in overcoming the challenge of a demanding mathematics curriculum.*

Key words: Peer teaching, performance in mathematics, social interaction theory.

## INTRODUCTION

Mathematics is a core subject in the school curriculum; compulsory at both primary and secondary school levels in Kenya. It is the foundation of scientific and technological knowledge that is vital in the socio-economic development of the nation. It is also used as a basic entry requirement into most of the professional courses offered at degree level such as commerce, economics, actuarial science, engineering, medicine, pharmacy and architecture as prescribed by Kenya Universities and Colleges Central Placement Services (KUCCPS) in 2014.

Smith (2004) summarizes the importance of mathematics to society and the knowledge economy, stating thus:

> 'Mathematics provides a powerful universal language and intellectual tool kit for abstraction, generalization and synthesis. It is the language of science and technology. It enables us to probe the natural universe and to develop new technologies that have enabled us control and master our environment, and change societal expectations and standards of living'(p.11).

The functional aspect of mathematics stems from its importance as the language of science, engineering and technology, and its role in their development. This role is as old as mathematics itself and it can be argued

that, without mathematics, there can be neither science nor engineering (Lancaster, 2013). In Kenya, The National Committee on Educational Objectives and Policies (RoK, 1976) recommended the restructuring of the education system curriculum in order to have more streams of science, mathematics, technical and vocational subjects with the aim of making school leavers employable.

Performance in mathematics depends largely on effective teaching and learning process (UNESCO, 2008). Developmental learning theorists brought to education the idea that teachers can be more effective if they can organize learning in a step-by-step manner and connect it to the learner's prior knowledge and experiences (Piaget, 1953). The activities selected in the teaching and learning of mathematics must nurture plenty of student activity and acquisition of learning skills and that an enabling environment should be created to give the learner the opportunity to interact freely with fellow learners.

For effective acquisition of mathematical skills teachers are advised to use heuristic methods as much as possible so as to involve the learners and keep them interested in the subject. They should have a free hand to use their own approaches (KIE, 2006).

## LITERATURE REVIEW

### Mathematics as a Discipline

Mathematics is studied for a variety of reasons. According to Paisey (2010), mathematics is a passage to understanding many other subjects. In a broad sense it forms the basis of many of the sciences such as physics and astronomy (Lyons, 2008). Mathematics teaches children important problem solving skills that they can apply to other aspects of their lives. It helps them to think in a logical manner, and also helps them to view and analyze things in a more sophisticated way. According to Samuelson (2011), to know mathematics means that a student has learned and mastered mathematical skills needed to find a solution to a particular problem. Often these skills take a long time to perfect (Avital, 2010). The teacher needs to communicate this knowledge in a clear and informative manner (Soer, 2009). In addition, the ability to make learning fun and worthwhile is also crucial. Mathematics provides a means of communication which is powerful, concise and unambiguous tool used to represent, to explain and to predict phenomena. Mathematical skills are highly valued and sought after; learning mathematics leads to development of logical and critical reasoning and develops analytical and problem solving skills to a high degree (Smith, 2004). In modern times, adoption of mathematical methods in the social, medical and physical sciences has expanded rapidly, confirming mathematics as an indispensable part of all school curricula and creating great demand for university-level mathematical training. The main goal of mathematics education in schools is mathematisation of the child's thinking.

### Effect of Peer Teaching on Students' Performance

Peer tutoring has been researched as an effective strategy to engage students and promote academic success. It improves mathematics performance for students at risk or experiencing mathematics disabilities (Lazarus, 2014). Findings of 65 independent evaluations of school tutoring programs showed that tutored students outperformed many students in examinations, developed positive attitudes towards the subject matter and gained better understanding of the subject (Cohen *et al*, 1982). Vassay (2010) conducted a study of peer teaching in college mathematics and found that it greatly affects the intellectual and moral values of the

students such as the ability to express their ideas, mastery of different concepts, time management, and sense of responsibility, sharing, self-discipline, self-reliance, self-confidence, resourcefulness, cooperation and obedience.

Although it is assumed that peer tutoring primarily benefits those who are tutored, Goodlad and Hirst (1989) point out that both the tutor and the recipient make significant gains. Effects on both tutors and students were positive in the areas of learning, attitude towards the subject matter and self-concept (Cohen *et al,* 1982). For the tutor, benefits result from reinforcing existing knowledge of fundamental concepts and gaining a better understanding of the field of study. In addition tutors develop a sense of efficacy, gain insight in the teaching and learning process, and discover meaningful applications of the subject matter. For the recipients of tutoring the advantages include individualized instruction, more contact time with a 'teacher', the opportunity to discuss material and to ask questions in a non-threatening and supportive setting, and interaction and bonding with peers (Goodlad and Hirst, 1989). The teacher in turn, benefits from this model of instruction by an increased opportunity to individualize instruction, increased facilitation of inclusion or mainstreaming and opportunity to reduce inappropriate behaviours (Topping, 2008). Peer tutoring works best when students of different ability levels work together (Kunsch *et al*, 2007). The old adage, "those who teach learn twice" holds true for peer tutoring and when it is used, learning becomes more effective because learners are teaching themselves (Whitman, 1988). While one student may excel in mathematics, another student may be top-notch in English. These students can work together to help each other understand difficult concepts, while deepening their own knowledge of the subject.

Students with difficulties learning mathematics can be found in almost every classroom. The potential causes of these difficulties are numerous and can be explained by such child characteristics as intellectual functioning, motivation, problem-solving skills, memory skills, strategy acquisition and application, and vocabulary. Research on peer tutoring has demonstrated that peer tutoring can be successfully implemented with tutors of various ability levels, including children with advanced skills and children with learning disabilities (Fuchs *et al,* 2002).

A study conducted in Nigeria by Okilwa and Shelby (2010) on the effects of peer tutoring on academic performance of students with disabilities in Grades 6 through to 12 reported peer tutoring as effective for special education students in both general education and special education settings. Peer tutoring implemented across subject areas such as language, arts, mathematics, science and social studies showed positive academic effects. Additionally, Bowman-Perrot *et al* (2013) conducted a meta-analysis on the effect of peer tutoring across 26 single-case research experiments for 938 students in Grades 1 – 12. The findings were that peer teaching is an effective intervention regardless of dosage, grade level or disability status.

Tracey *et al* (2007) conducted a research in South Africa which describes the experiences of learners involved in a cross-cultural peer teaching initiative between a privileged private school and a township school in Port Elizabeth. The aim was to explore the possible advantages of cross-cultural peer tutoring on certain sections of the new mathematics curriculum. It was found that the understanding of the mathematics topics dealt with during peer teaching session was enhanced and both groups gained from the peer teaching interaction. This cross-cultural interaction brought understanding and sensitivity towards people from different cultural, racial

and socio-economic groups. It was extremely valuable in overcoming the negative lingering effects of apartheid.

According to Shihab (2011) as cited by Lazarus (2014) a benefit of cooperative learning is to provide students with learning disabilities, mathematics disabilities and social interaction disabilities an instructional arrangement that enhances the application and practice of mathematics and collaborative skills within a natural setting in a group activity. The studies discussed in this section were done outside Kenya so this study intended to find out whether peer teaching methods such as class-wide peer tutoring, cooperative learning and small group discussions had any effect on students' academic performance, positive character building and development in Bungoma South Sub County.

## STATEMENT OF THE PROBLEM

Performance in mathematics in Kenya continues to be below expectations despite numerous research efforts to remedy the situation. Attempts have been made to counter the problem of poor performance in mathematics in schools but no significant improvement has been recorded (KNEC, 2014). For instance, interventions such as the SMASSE project which is a joint venture by the Government of Kenya and Japanese International Co-operation Agency (JICA), In-Service Education and Training (INSET) through seminars and workshops organized by the Ministry of Education are aimed at improving performance. Statistics show that performance has continued to be poor with Mathematics being recorded as one of the subjects whose performance dropped in the 2013 KCSE (KNEC Report, 2014). Poor performance in this key subject continues to cause concern to education stakeholders, parents and the students given that mathematics is to act as a catalyst to career progression and the achievement of Kenya Vision 2030.

## PURPOSE OF THE STUDY

The purpose of this study was to determine the effect of peer teaching on students' performance in mathematics in the teaching and learning process.

## OBJECTIVE OF THE STUDY

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## RESEARCH DESIGN AND METHODOLOGY

A descriptive survey design was adopted for the study. This design enabled the collection of the current information from the teachers and students about the effect of peer teaching on the students' performance in mathematics.

## THE SAMPLE

A total of 12 schools were selected from Bungoma South Sub County using stratified random sampling to ensure equal representation of County, Sub County and Private schools. Four boys' schools, five girls' schools and three mixed schools were selected as shown in table 1.

**Table 1: Categories of schools by school type**

| Category of school | Boys' | Girls' | Mixed | Total |
|---|---|---|---|---|
| **County** | 3 | 2 | 1 | 6 |
| **Sub County** | 2 | 2 | 1 | 5 |
| **Private** | - | - | 1 | 1 |
| **Total** | 5 | 4 | 3 | 12 |

Purposive and simple random sampling techniques were used to get the sample of 12 Heads of Department, 24 teachers of mathematics and 176 Form Three students as shown in table 2.

**Table 2: Sample Size**

| Respondents | Population (N) | Sample Population(n) | % | Type of sampling |
|---|---|---|---|---|
| **Students** | 1257 | 176 | 14.00 | Random |
| **Teachers** | 66 | 24 | 36.36 | Random |
| **Heads of Departments** | 12 | 12 | 100 | Purposive |

The teachers of mathematics were selected because they are trained and understand the use of various methods of teaching mathematics. The level of students selected for the study have learned mathematics for a reasonable period of time to make informed decision or assessment about the value of peer teaching in mathematics as opposed to other methods. The students and the teachers were found to be familiar with peer teaching strategy as a method of teaching mathematics.

## RESEARCH INSTRUMENTS AND DATA COLLECTION

Four instruments were used to collect data in this study; Mathematics Teachers' Questionnaire, Students' Questionnaire, Students' Achievement Test and Heads of Department interview schedule. Kombo and Tromp (2013) argue that the questionnaire is a research instrument that gathers data over a large sample. Items in the questionnaires and the Heads of Department interview schedule were mainly concerned with the effect of peer teaching among students on their academic performance, form three topics better understood when students explain/demonstrate to others in the teaching of mathematics and if there are any other desirable characteristics that students develop other than academic performance, from peer teaching among students. The Students' Achievement Test was to provide a common measure to assess students' performance in mathematics. The test was administered to the students before exposure to peer teaching as a pretest to measure their performance. The same students were exposed to peer teaching and small group discussion then given a post test. The scores of these tests were used to obtain information about the effect of peer teaching methods on students' performance.

The research instruments were piloted in two randomly selected schools in Bungoma South Sub-County which were not included in the main study. Test-retest method was used where the instruments were administered to the respondents from the pilot schools at two different times. The correlation coefficient between the two sets of data was computed using the formula for Pearson's product-moment correlation coefficient (r) as shown below:

$$r = \frac{N\sum XY - \sum X.\sum Y}{\sqrt{[N\sum X^2 - (\sum X)^2][N\sum Y^2 - (\sum Y)^2]}}$$

Where r = the Pearson's coefficient of correlation index

X = scores obtained during the first trial

Y = scores obtained after a week.

The calculated value was 0.811. According to Orodho (2005) a correlation coefficient (r) of about 0.75 should be considered high enough to judge the reliability of the instrument. Since the value obtained was greater than 0.75, the instruments were considered reliable.

## RESULTS AND DISCUSSION

### The relationship between peer teaching and students' performance during classroom instruction

The students were asked to establish if learning of mathematics by being taught by their peers help them to understand and learn better. The findings are shown in table 3.

**Table 3: Students' response on use of peer methods in mathematics**

| Response | Frequency | Percentage |
|---|---|---|
| **Yes** | 168 | 95.5% |
| **No** | 8 | 4.5% |
| **Total** | 176 | 100.0% |

The results show that 168(95.5%) students affirmed that learning of mathematics through being taught by their peers help them to understand and learn better. This is in agreement with the findings of Cohen *et al* (1982) who analyzed the findings of the educational outcomes of peer tutoring which showed that tutored students outperformed many students in examinations, developed positive attitude towards the subject matter and gained better understanding of the subject.

Table 4 shows the number of students who affirmed that their grades improved the previous term as a result of being taught by their peers.

**Table 4: Grade improved by peer teaching**

| Response | Frequency | Percentage |
|---|---|---|
| **Yes** | 163 | 92.6% |
| **No** | 13 | 7.4% |
| **Total** | 176 | 100.0% |

The findings show that 163(92.6%) students agreed that their grade in mathematics improved due to the help they got from their peers in the previous term. The students reported that when they teach one another in group discussions they understand more and retention increases. These findings are in agreement with those of Tracey *et al* (2007) who set out to investigate the effect of cross-cultural peer teaching in South Africa. They found that the understanding of mathematics topics dealt with during peer teaching session was enhanced and that both the peer teachers and the peer learners gained from the peer teaching interaction.

The students were also asked to determine if complex mathematics questions became clearer after being taught by peers in small group discussions. The findings revealed that 154 (87.5%) of the respondents agreed that complex mathematics questions become clearer after being taught by their peers in small group discussions. One student put it thus:

> "Peers use different approaches on one sum; hence I have a variety of choices. I choose the easiest and simplest thus improving more"

These findings are in agreement with those of Nguyen (2013) who did a research on peer tutoring as a strategy to promote academic success and found that by explaining concepts in detail, high level questioning, and the use of supportive communication skills, peer teachers can help low performing students master material previously introduced in a traditional classroom setting and build on their knowledge using higher order thinking skills.

Students were further probed to establish if they understood when taught by their peers during mathematics lessons. The findings are presented in table 5.

**Table 5: Students response to whether they understand when taught by their peers**

| Response | Frequency | Percentage |
|---|---|---|
| **Yes** | 165 | 93.75% |
| **No** | 11 | 6.25% |
| **Total** | **176** | **100%** |

The findings show that 165(93.75%) understand when taught by peers during mathematics lessons due to the following reasons:

i. Peers explain concepts in simpler and understandable terms and according to their level of understanding

ii. Peers can be asked questions and for more explanations freely

iii. Interact and discuss openly without fear

These findings are in agreement with the determinations of Tracey *et al* (2007) who found that one advantage of peer teaching is that learners feel comfortable asking questions of learners their own age.

To further determine the effect of peer teaching on students' performance in mathematics, the students were asked questions to establish their opinion towards mathematics and peer teaching methods. The findings are presented in table 6.

**Table 6: Students responses on perceptions towards peer teaching methods**

| | Statements | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree | Total |
|---|---|---|---|---|---|---|---|
| 1. | Mathematics becomes easy when taught by my classmates | 66 (37.5%) | 87 (49.4%) | 15 (8.5%) | 5 (2.8%) | 3 (1.7%) | 176 100% |
| 2. | Mathematics is theoretical and complex to be taught by my classmates | 14 (8.0%) | 22 (12.5%) | 25 (14.2 %) | 64 (36.4%) | 51 (28.9%) | 176 100% |
| 3. | Small group discussion improves my understanding of mathematics | 105 (59.7%) | 64 (36.4%) | 6 (3.4%) | 1 (0.5%) | 0 (0.0%) | 176 100% |
| 4. | I seek assistance from my classmates when unable to solve a mathematics problem | 104 (59.1%) | 64 (36.4%) | 5 (2.8%) | 3 (1.7%) | 0 (0.0%) | 176 100% |
| 5. | My interest increases when a fellow student solves a mathematics problem on the board | 100 (56.8%) | 56 (31.8%) | 16 (9.1%) | 1 (0.5%) | 3 (1.7%) | 176 100% |

The findings in show that a total of 153(86.9%) students were of the opinion that mathematics becomes easy when taught by their classmates, 115(65.3%) disagreed with the opinion that mathematics is theoretical and complex to be taught by their classmates, while 169(96.1%) were of the opinion that small group discussion improves their understanding of mathematics. Peer teachers reinforce their own learning by instructing others (Briggs, 2013). On the question of learners seeking assistance from their peers when unable to solve a mathematics problem a total of 168(95.5%) were in agreement. This is in agreement with Mwelese (2014) who investigated effectiveness of classroom practices to achievement in mathematics and found that a higher percentage of students who sought help from their peers scored highly in an achievement test than those who sought the teacher's help; and 156(88.6%) were of the view that their interest increases when a peer solves a mathematics problem on the board. These findings agree with those of Tracey *et al* (2007) that learners get motivated by seeing their peers mastering concepts.

**Mathematics Achievement in Small Group Instruction**

To determine the effect of peer teaching among students on students' mathematics achievement, the students' achievement test was administered as a pre-test before peer teaching was done and the same was used as a post-test after exposure of students to peer teaching. The results were computed using a students't-test. The results are presented in table 7.

**Table 7: Paired samples statistics and tests**

| Test | Mean | N | Std. Dev. | 95% | confidence | interval |
|---|---|---|---|---|---|---|
| **Pre-test** | 4.12 | 176 | 3.054 | t | df | Sig(2-tailed) |
| **Post-test** | 6.87 | 176 | 3.404 | -19.033 | 175 | 0.000 |

The findings show that there was a significant difference in the scores for pre test (M = 4.12, SD = 3.054) and post test (M = 6.87, SD = 3.404); t critical at 175 degrees of freedom = - 19.033, p = 0.000 at $\alpha = 0.005$. These values suggest that peer teaching has a significant effect on students' achievement in mathematics. This provided evidence that peer teaching methods are effective in producing academic gains in mathematics among students. These findings are in agreement with those of Bowman-Perrot *et al* (2013) who did a meta-analysis of the academic impact of peer teaching and found greater academic gains were made by students engaged in peer teaching interventions.

**Use of Peer Teaching on Mathematics Concepts covered in Form Three**

The questions asked to the teachers in the teachers' questionnaire sought to establish if there are any particular concepts in Form 3 Mathematics which are understood better when students explain or demonstrate to other students in the teaching of mathematics. The findings are presented in table 8.

**Table 8: Teachers response on use peer teaching on mathematics concepts**

| Response | Frequency | Percentage |
|---|---|---|
| **Yes** | 22 | 95.65% |
| **No** | 1 | 4.35% |
| **Total** | **23** | **100%** |

The results show that 22(95.65%) of the teachers agreed that there are concepts better understood when students explain or demonstrate to one another and revealed that this can be done with all the topics covered in Form 3 mathematics syllabus. However, the topics which were identified with a high frequency included:

i. Vectors

ii. Trigonometry

iii. Circles

iv. Quadratic Expressions and Equations and;

v. Commercial Arithmetic

These findings reveal that peer teaching is of great value to the teaching of mathematics. This is in agreement with Puchner (2003) who found that the elaboration of a topic by the student himself and the presentation of this in the classroom may under proper conditions; prove to be a very useful tool in the teaching process for the teacher and the learners.

**Social and Behavioural Gains from Use of Peer Teaching Methods**

Apart from the effect on academic performance in mathematics, the study also sought to determine if there are any other desirable characteristics students develop in the course of peer teaching amongst themselves. The heads of department revealed that the students improve in self-confidence, language expression, respect of others opinion as peer teaching allows them to interact and share ideas.

The teachers' responses were in agreement with the views of the heads of department. In addition the following benefits were stated:

i. Improved attitude, motivation and self-esteem

ii. Developing social skills and or solving social problems

iii. Discipline is enhanced leading to academic improvement

iv. Teamwork is enhanced, students learn to work as a team to achieve the best individual results at the end of their course

v. Leadership quality and group control

vi. Positive attitude towards work

vii. Developing communication and public speaking skills.

The students mentioned the following as some of the characteristics developed in the learners as they undertake peer teaching while learning mathematics:

i. Being confident, improves self-confidence and self- esteem

ii. Strengthens their relationship, unity and understanding leading to friendship

iii. Promotes teamwork and positive competition

iv. Becoming courageous and developing good oral and public speaking skills

v. Improves discipline, courtesy, persistence, concentration and time management

vi. Good moral behaviour, responsibility and desire to help others

vii. Free interaction with other students and positive attitude towards each other.

These findings are in agreement with Vassay (2010) who conducted a study of peer teaching in College Mathematics and found that it greatly affects the intellectual and moral values of the students; such as ability to express their ideas, mastery of different concepts, time management, and sense of responsibility, sharing, self-discipline, self-reliance, self-confidence, resourcefulness, cooperation and obedience.

## CONCLUSION

The findings from the Students' Achievement Test revealed that peer teaching and group discussions among students increases the scores for some of the students in the subject. The responses from the teachers' and learners' questionnaires show that the students' understanding and retention of subject matter is enhanced; and the attitude of the learners towards the subject increases. The development of a positive attitude by the students towards mathematics is one of the main goals of teaching mathematics.

Consistent use of peer teaching improves learners' achievement scores in mathematics. Peer teaching is highly effective in raising the standard of understanding of mathematics concepts; students performed significantly better as evidenced in the students' scores which increased in the students' achievement test following the administration of peer teaching and group discussion. It builds confidence in the students and allows them to interact and share ideas. However, this has not translated into good performance in national examinations due to other factors such as inadequate teaching and learning resources.

## RECOMMENDATIONS

Peer teaching should be embraced as a teaching method to help improve students feeling of success and to help them develop confidence in mathematics through their direct involvement. Students should be allowed to form discussion groups where peer teaching can be encouraged especially at the end of every topic. Group discussions should be encouraged to enable students who fear teachers to participate fully and ask questions to improve their performance.

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